國立臺灣科技大學
九十三學年度博士班考試試題

系所組別：機械工程系丁組
科　　目：系統與控制

題目共有五題，總分一百分

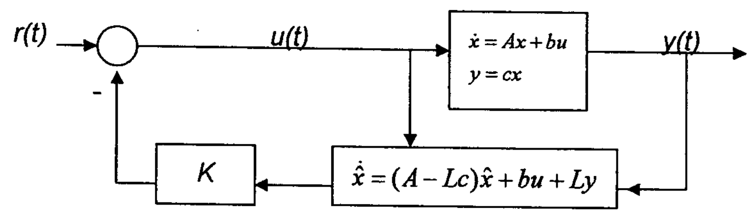
1. Please describe the difference between minimum phase system and non-minimum phase system. Specifically describe their transient behavior in step response, and effects on the Bode plot of the open-loop transfer function. Finally, comment on the effects on the sensitivity function if using a standard unity feedback structure. (20%)

2. Consider the linear state space system $\dot{x}=\begin{bmatrix}-1 & 0\\ 1 & 0\end{bmatrix}x+\begin{bmatrix}1\\0\end{bmatrix}u$, $y=\begin{bmatrix}0 & 1\end{bmatrix}x$.

(A) It is desired that the closed-loop poles at $\omega_n = 1$ rad/sec and $\zeta = \sqrt{2}/2$ using state feedback $u = -Kx$. Find the gain K that achieves this. (5%)

(B) If only the measurement of y is available for control. Construct a state estimator (i.e., write down the model equations of the estimator) and find the estimator gains that place the estimator poles at $\omega_n = 5$ rad/sec and $\zeta = 0.5$. (5%)

(C) If we define the error as $e(t) = x(t) - \hat{x}(t)$. Determine the controllability of the error dynamics from the reference command $r(t)$ and comment on its implications. (10%)



3. For the discrete system: $\dfrac{C(z)}{R(z)} = \dfrac{4(z+c)}{z^3 + az^2 + bz + 0.5}$.

(A) Specify the conditions under which the above system is stable. (10%)

(B) Employ a parameter plane to show the region for which the conditions in (a) are satisfied. (10%)

4. Please sketch the Nyquist plot for the system whose open-loop transfer function is $G(s)H(s) = \dfrac{2(s+2)}{s(s-1)}$. Find the phase margin and gain margin for this system. (20%)

5. Consider a system described by $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 0 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\0\end{bmatrix}u$, $x(0) = \begin{bmatrix}1\\0\end{bmatrix}$. If the cost function is designed as $J = \int_0^\infty \left(x^T \begin{bmatrix}1 & 0\\ 0 & 0\end{bmatrix} x + u^T u \right) dt$. Find the optimal control law $u=-Kx$ such that the cost J is minimized. Also determine the value of the optimal cost. If optimal control infeasible; state the reason why and show the value that the optimal cost would approach. (20%)